Spraying Marine Algae Extracts and Some Growth Regulators to Enhance Fruit Set, Yield and Fruit quality of Winter Guava

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DOI: 10.21608/jalexu.2021.105537.1019

Article Information

Received:November 11st 2021

Revised: December 8th 2021

Accepted:December 12nd 2021

Published: December 22nd 2021

ABSTRACT: This experiment was carried out during 2018 and 2019 seasons to investigate the effect of spraying marine algae extracts (*Ascophyllum nodosum*) and some growth regulators (GA3 and NAA) to reduce fruit drop and improve fruit yield and quality of winter guava trees cv. 'Maamoura' grown in Rasheed area, El Beheira, governorate, Egypt and cultivated at a distance of 4 x 4 m. The irrigation method was flood irrigation from the Nile River. Trees, as uniform as possible in shape and size, were selected and had the same horticultural management including the control. The experiment involved ten foliage spraying treatments as follows: control, sprayed with water, Seaweed extract at (5, 10 and 15 mg/l), GA_3 at (1, 2 and 3 mg/l) and NAA at (1, 2 and 3 mg/l).

The obtained results showed that, GA_3 at 3mg/l and Seaweed extract at 15 mg/l had the highest positive effect to improve vegetative growth, total chlorophyll (SPAD), the percentages of fruit set, yield, and total soluble solids (TSS). Moreover, it increased N, P and K in the leaves in the two seasons, as compared to the control and the other treatments. In addition, it improved significantly the number of fruits per tree, fruit weight, length and firmness. Reduction in the percentages of total acidity was observed as compared to the control, in the two seasons.

Keywords: *Maamoura guava; foliar application; Seaweed extract; GA_3; NAA; yield; fruit quality*.

INTRODUCTION

Guava (*Psidium guajava* L.) which belongs to family Myrtaceae is a native of tropical America. The fruit is rich in Vitamin-C and pectin besides being a good source of thiamine and riboflavin. It is known as 'apple of tropics' and can be grown in wide range of soil and climatic conditions. Guava is important fruit crop which is grown commercially in tropical and subtropical regions of the world **(Gollagi *et al.*, 2019)**.

Seaweeds or algae extracts include green, brown and red marine macro-algae, and brown seaweed extracts are widely used in horticulture crops. The raw material, geographical location of harvested algae and algal species, as well as the extraction method, all influence the composition of seaweed extracts, Polysaccharides, proteins, polyunsaturated fatty acids, pigments, polyphenols, minerals, plant growth hormones, and other physiologically active chemicals are transported from algal biomass to the liquid phase. They benefit humans, animals, and plants by primarily protecting an organism from biotic and abiotic stress and have various commercially valuable products such as pharmaceutical and cosmeceutical compounds **(Al- Musawi, 2019)**

Plant growth regulator like GA_3 and NAA affects flower and fruit setting, cell growth, apical dominance, geotropism and photoperiod. GA_3 had the highest fruit retention and yield followed by amcotone, activated dry yeast and NAA in both winter and rainy seasons. The growth regulators spray in addition increases fruit weight, total soluble solids (TSS), fruit weight, carotene, reducing sugars, total sugars and vitamin-C and decreased tannin and fruit acidity. The Triacontanol is present as a natural component of plant wax and bee wax **(Abubakar *et al.*, 2013).**

GA_3 is responsible for cell elongation, rather than cell division **(Francis and Sorrell 2001).** Gibberellins are natural growth hormones playing a primary role in stimulating the auxin reaction, which helps controlling the growth, as well as its direct effect on internode elongation, flowering, fruiting, quality and yield. The most typical property of gibberellins is the promotion of stem growth **(Graebe, 1987).** GA_3 encourages the cell division and elongation; increases the stalk length, enhances flower and fruit volume. Auxins promote shoot elongation, thin tree fruit and flower formation **(Fishel, 2006).**

Naphthaleneacetic acid (NAA) is an organic compound, which is a plant hormone in the auxin family and is an ingredient in many commercial horticultural products; it is also a rooting agent and used for the vegetative propagation of plants from stem and leaf cutting **(Dimitrios *et al.*, 2008).** It has important role in fruit formation, abscission cell elongation, apical dominance, photoperiod and geotropism **(Haidry *et al.*, 1997).**

The purpose of this study was to investigate the effect of foliar application of seaweeds, GA3 and NAA on vegetative growth, fruit set, yield, fruit quality and leaf mineral of 'Maamoura' guava trees.

MATERIALS AND METHODS

This study was conducted during 2018 and 2019 seasons to investigate the effect of foliar application of marine algae extracts (*Ascophyllum nodosum*), GA3 and NAA to reduce fruit drop and improve fruit yield, fruit quality and leaf mineral content of winter guava cv. 'Maamoura' trees grown in Rasheed area, El Beheira, governorate, Egypt and cultivated at a distance of 4 x 4 m. the irrigation method was flood irrigation from the Nile River. During the entire season, all trees under study received the same applied fertilization program in orchard i.e. 2-3 miqtaf decomposed livestock manure +1 kg super phosphate and incorporated well in the soil in winter. In March and July, 200 - 250 g nitrogen was added to each tree in two batches. Potassium fertilizer was also added in two batches, exchange with nitrogen, at the rate of 150 - 250 kg per acre. Microelements was added both as foliar application to the shoot system and as soil application when deficiency symptoms appear. The physio-chemical analysis of experimental soil is indicated in **Table** (1)**.**

Table (1): The physical and chemical analysis of the experimental soil

Depth (cm)	**Textural class**	**pH**	**Total $CaCO_3$ (%)**	**EC (ds/m)**		**O.M. (%)**
0-45	Yellow soil	8.00	5%	0.28		3.3
	Cations (meq/ 100 g soil)			Anions (meq/ 100 g soil)		
Na^+	K^+	Ca^{2+}	Mg^{2+}	HCO^{3-}	Cl^-	SO_4^{2-}
5.6	0.33	0.45	0.55	1.4	2.8	2.8

The following treatments were sprayed on the trees:

1. Control (Tap water)
2. Seaweed extract at 5 mg/l. (Sea-Hammer)
3. Seaweed extract at 10 mg/l.
4. Seaweed extract at 15 mg/l.
5. GA_3 at 1 mg/l.
6. GA_3 at 2 mg/l.
7. GA_3 at 3 mg/l.
8. NAA at 1 mg/l.
9. NAA at 2 mg/l.
10. NAA at 3 mg/l.

The Sea Hammer compound was used as the source of the algae *escophyllum nodosum sp*. (85% alge extract ,10% humic acid and 5% potassium).

Gibberellic acid (From Green Geb 10% GA3 tablets) and naphthalene acetic acid (from Green hand tonic) (contains: 1.2% Sodium A Naphthyl acetic acid, 0.6% Sodium O-Nitrophenollate, 0.9% Sodium P- Nitrophenolate and 0.15% Sodium 2,4- Dinitrophenolate).

They were sprayed three times:

1. one month before full flowering (25 May)
2. one month after fruit setting (10 July)
3. one month before harvest (20 August)

The previous treatments were arranged in Randomized Complete Block Design (RCBD), each treatment was replicated on 3 trees. The effect of the previous treatments was studied by evaluating their influence on the following parameters.

1.Vegetative Parameters

Samples of three trees of each experimental unite were taken to determine growth parameters at the middle of each season as follows.

1.1 Shoot length (cm)

1.2 Shoot diameter (mm)

1.3 Total chlorophyll in the fresh leaves was determined as SPAD units by using Minolta chlorophyll meter (SPAD, 501).

2.Fruit set (%), yield (kg/tree) and yield components

2.1 Fruit set (%)

Twenty branches from each of the eight treatments were chosen at random to evaluate the percentage of fruit set; they were then tagged, and their blooms were counted when they were in full bloom. Fruitlets were also counted and recorded in mid-June, as fruit set was ideal. As a percentage of the total number of blooms, fruit set was estimated as follows:

Fruit set (%) =

$$\frac{No\ of\ \ fruit\ lets}{No\ of\ \ opened\ \ flowers} \mathrm{X}\,100$$

2.2 Yield (kg/tree)

At harvest time, in 10th, October in the two seasons, the yield of each treatment was measured in kilogrammes per tree. (mature fruits were picked, counted and weighed in Kg per tree).

Sample of 10 fruits per tree from each replicate was collected randomly, i. e. 50 fruits from each applied Samples were taken at random at harvest in both seasons and brought to the laboratory quickly to determine physical and chemical fruit characteristics.

2.3 Yield components

2.3.1 Physical fruit characteristics

The following parameters were determined:

2.3.1.1 Fruit weight (g/ fruit)

Fruit samples were weighted and the average fruit weight for each replicate was calculated in gram.

2.3.1.2 Fruit length (cm) and diameter (cm): were measured by using Hand caliper.

2.3.1.3 Fruit firmness (pound/ Inch^2): Flesh firmness was measured in two opposite sides of the fruit using magness taylor pressure tester and expressed as (pound/ Inch^2) according to (Magness and Taylor, 1982).

2.3.2 Chemical fruit characteristics

2.3.2.1 Total soluble solids (TSS %)

The percentage of TSS was determined in guava fruit juice using a hand refractometer according to (A.O.A.C, 1995).

2.3.2.2 Total acidity (%)

The percentage of total acidity in fruit juice was calculated using Chen and Mellenthin (1981) method. Five milliliters from the obtained juice were used to determine the titratable acidity. The titratable acidity was expressed as grams citric acid/ 100 milliliters fruit juice.

2.3.2.3 Vitamin C (Ascorbic acid) (mg/ 100g pulp)

The ascorbic acid content of the juice was determined by titration with 2, 6 dichloro phenol-indo-phenol (A.O.A.C., 1995) and calculated as milli-grams per 100 ml of juice.

2.3.2.4 Total sugars (%)

Total sugar (%) was determined calorimetrically using phenol and sulphuric acid, according to Malik and Singh (1980) extracted from 5-gram fresh pulp.

3.Leaf mineral compositions (N,P and K)

Samples of the third pairs of leaves from the base of none fruiting shoots were collected in mid - August in both seasons of the study. At random from the previously tagged shoots, samples of 40 leaves /tree were taken, The leaf samples were washed in tap and distilled water before being oven dried at 70°C to a consistent weight and crushed. To assess the leaf mineral content, each sample's ground material was digested with H_2SO_4 and H_2O_2 according to the manufacturer's instructions Wolf (1982). Total nitrogen and phosphorus in the digested material were measured colorimetrically according to Evenhuis and De waard (1980) and Murphy and Riley (1962), respectively and potassium was determined using a flame photometer, as stated by Chapman and Pratt (1978). The concentrations of N, P and K were expressed as percent.

4.Statistical analysis

The results of the measured parameters were subjected to a computerised statistical analysis of variance (ANOVA) using the MSTAT programme, and the means of treatments were compared using LSD at 0.05 according to Snedecor and Cochran (1990).

The purpose of this research was to see how foliar spraying of seaweed extract, GA3, and NAA on guava cv. "Maamoura" trees improved fruit set %, vegetative development, yield, fruit quality, and leaf mineral content.

RESULTS AND DISCUSSION

1. Effect of seaweed extract, GA3 and NAA growth regulators on vegetative growth properties

The results regarding the shoot length (cm) and diameter (mm) and total chlorophyll (SPAD) of guava cv. "Maamoura" as influenced by seaweed extract, GA_3 and NAA levels, during 2018 and 2019 are presented in Table (2).

As for seaweed, in the two seasons, the three concentrations of seaweed significantly increased the shoot length (cm), shoot diameter (mm) and the leaf total chlorophyll (SPAD) of guava cv. Maamoura compared to the control. In the meantime, increasing seaweed extract concentration significantly increased the shoot length, shoot diameter and the leaf total chlorophyll of guava cv. "Maamoura".

As for GA3, in the two seasons, the three concentrations of GA3 significantly increased the shoot length (cm), shoot diameter (mm) compared to the control. In the meantime, there were significant differences among the three GA3 concentrations so that the shoot length and shoot diameter increased by increasing the concentrations of the GA3. in the two seasons, the two higher (2mg/l and 3mg/l) concentrations of GA3 significantly increased the leaf total chlorophyll of guava cultivar Maamoura compared to the control and the lowest concentration of GA3(1mg/l) treatment. While, the lowest concentration of GA3 (1mg/l) caused a significant decrease in the leaf total chlorophyll of guava cultivar Maamoura compared to the control in the two seasons.

As for NAA, in the two seasons, the two higher concentrations of NAA (2mg/l and 3mg/l) significantly increased the shoot length (cm) and shoot diameter (mm) compared to the control treatment. The highest concentration of NAA(3mg/l) caused a significant increase in leaf total chlorophyll (SPAD) of guava cultivar Maamoura compared to the control and the two lower concentrations (1mg/l and 2mg/l). In the meantime, the lowest concentration caused a significant decrease in the leaf total chlorophyll of guava cultivar Maamoura compared to the control and the other treatments, in the two seasons of the experiment.

It was clear that seasweed had a good influence on vegetative growth because of its high content of growth promoting hormones like IBA, cytokinins, IAA, gibberellins, and amino acids,vitamins, antibiotics and micronutrients (Zodape *et al*., 2008). Chlorophyll content was enhanced by seaweeds and seaweed products (Blunden *et al.,* 1997), due to the reduction in chlorophyll degradation, which caused in part by betaines in the seaweed extract (Whapham *et al.*, 1993). Because of increased photosynthetic rates or the most efficient use of photosynthetic yields, gibberellic acid GA3 has the ability to boost plant growth and improvement in a number of experimental settings(Hifny *et al*., 2017). There have been various investigations on the role of GAs in photosynthetic processes in this scenario. Davies (1987) NAA is the artificial version of auxins, as indicated. Which play an important part in vascular tissue, cell division, differentiation, apical dominance, leaf withering, and fruit abscission.

Table (2): Effect of seaweed extract, GA3 and NAA growth regulators on vegetative growth and total chlorophyll

Treatments	Shoot length (cm)		Shoot diameter (mm)		Total chlorophyll (SPAD (μ Molm^{-2}))	
	Seasons					
	2018	2019	2018	2019	2018	2019
Control	52.83g	59.17g	2.69g	3.01g	40.26e	45.09e
Seaweed 5 mg/l	62.29e	69.77e	2.92e	3.27e	42.14d	47.20d
Seaweed 10 mg/l	69.21c	77.51c	3.24c	3.63c	46.82b	52.44b
Seaweed 15 mg/l	76.90b	86.13b	3.67a	4.11a	52.02a	58.26a
GA_3 1 mg/l	67.46cd	75.56cd	2.78f	3.12f	38.70f	43.34f
GA_3 2 mg/l	74.95b	83.94b	3.09d	3.46d	43.00d	48.16d
GA_3 3 mg/l	83.29a	93.28a	3.44b	3.85b	47.78b	53.51b
NAA 1 mg/l	51.90g	58.12g	2.60g	2.92g	36.23g	40.58g
NAA 2 mg/l	57.66f	64.58f	2.89e	3.24e	40.26e	45.09e
NAA 3 mg/l	64.07de	71.76de	3.21c	3.60c	44.73c	50.10c

Means with the same letters within each column are not significantly different at 0.05 level of significance

2. Effect of seaweed extract, GA3 and NAA growth regulators on fruit set and yield components

Results regarding fruit set (%), fruit weight (g), number of fruits/ tree and yield (kg/ tree) of guava cv. "Maamoura" as influenced by seaweed extract, GA_3 and NAA levels are presented in **Table (3)**.

Results presented in **Table (3)** indicated that, in the two seasons, the three concentrations of seaweed significantly increased fruit set (%), fruit weight (g), number of fruits/ tree and yield (kg/ tree) of winter guava cultivar Maamoura compared to the control treatment. In the meantime, there were significant differences among the three treatments so that fruit set (%) and fruit weight(g), number of fruits/ tree and yield (kg/ tree) increased by increasing the concentrations of seaweed extract.

As for GA_3, in the two seasons, the three concentrations of GA3 significantly increased fruit set (%) and fruit weight(g), number of fruits/ tree and yield (kg/ tree) of winter guava cultivar Maamoura compared to the control treatment, except for the lowest concentration (1 mg/l) for the number of fruits/ tree in the two season. In the meantime, there were significant differences among the three treatments, in the two seasons for the four measured traits.

As for NAA, in the two seasons, the three concentrations of NAA significantly increased fruit set (%) and fruit weight(g), number of fruits/ tree and yield (kg/ tree) of winter guava cv. Maamoura compared to the control treatment, except for the lowest concentration (1 mg/l) for the number of fruits/ tree in the two seasons and the lowest concentration for yield (kg/ tree) in the second season. In the meantime, there were significant differences among the three treatments for all traits, except between the two higher concentrations (2 and 3 mg/l) in the first season for the number of fruits/ tree.

The above results clear that, seaweed has a good influence on yield and fruit quality and this could be because of its high content of growth promoting hormones like IBA, IAA, cytokinins, gibberellins,vitamins, micronutrients, amino acids, and antibiotics **(Zodape *et al*., 2008). Baghdady *et al.* (2014)** sprayed In comparison to control plants, Valencia orange trees treated with GA3 at concentrations of 15 or 25 at full bloom stage had higher initial and ultimate fruit set percentages. Fruit weight increased by increasing the beneficial effect of GA3 from the mobilization of food reserves and accumulation of more pulp. This result is in conformity with that of **Lal *et al*. (2013)** on guava.

The exogenous supply of NAA treatment aided in the strengthening of the middle lamella and, as a result, the cell wall, and may have increased the mobilisation of food materials and minerals from other parts of the plant towards the development of highly active metabolic sink fruits, resulting in increased fruit weight. **(Katiyar *et al.*, 2009).** These observations are also in line with what has been described by **Anawal *et al.* (2015)** in the pomegranate and **Pandey *et al.* (2001)** in guava. **Vani *et al*. (2020)**, also found that, The use of GA3 and NAA enhanced cell proliferation and cell elongation, which resulted in larger fruits.

The rise in yield, which was accompanied by an increase in the quantity of fruits, a low percentage of fruit drop, higher fruit retention, and increased fruit size and weight under the growth regulators treatment, was verified by those previously reported by **Jawed (2017)**.

Table (3): Effect of seaweed extract, GA3 and NAA growth regulators on fruit set and yield components

Treatments	Fruit set (%)		Fruit weight (g)		Number of Fruit/ tree		Yield (Kg/ tree)	
	Seasons							
	2018	2019	2018	2019	2018	2019	2018	2019
Control	56.62e	60.61e	142.32h	167.47h	83.11fg	104.28fg	11.82f	17.46f
Seaweed 5 mg/l	65.24f	73.07f	158.07f	196.22e	102.97de	115.32de	16.27d	22.62d
Seaweed 10 mg/l	72.50c	81.20c	176.74d	220.24c	114.41c	128.13c	20.22b	28.21b
Seaweed 15 mg/l	80.55a	90.22a	197.49b	246.93a	127.12a	142.37a	25.01a	34.93a
GA_3 1 mg/l	61.57g	68.96g	167.40e	179.25f	95.69f	107.17f	16.01d	19.21e
GA_3 2 mg/l	68.41d	76.62d	187.11c	201.39d	106.32d	119.08d	19.89c	23.98d
GA_3 3 mg/l	76.01b	85.13b	209.11a	225.99b	118.13b	132.31b	24.70a	29.90b
NAA 1 mg/l	58.80h	65.86h	147.67g	172.78g	90.03g	100.84g	13.30e	17.42f
NAA 2 mg/l	65.34f	73.18f	165.19e	194.20e	100.04e	112.04e	16.53d	21.75e
NAA 3 mg/l	72.60c	81.31c	184.65c	218.00c	111.15e	124.49c	22.52b	27.13c

Means with the same letters within each column are not significantly different at 0.05 level of significance

3. Effect of seaweed extract, GA3 and NAA growth regulators on some fruit physical properties

The results regarding fruit length (cm), diameter (cm) and firmness (Ib/ inch^2) of guava cv. "Maamoura" as influenced by seaweed extract, GA_3 and NAA levels are presented in **Table (4)**.

As for seaweed extract, results in **Table (4)** showed that, in the two seasons, the three concentrations of seaweed extract significantly increased fruit length (cm), fruit diameter (cm) and fruit firmness (Ib/ inch^2) compared to the control treatment, except for the lowest concentration (5 mg/l) for fruit diameter (cm), in the two seasons. In the meantime, there were significant differences among the three concentration (5, 10 and 15 mg/l) for fruit length, diameter and firmness which increased by increasing the concentrations of the seaweed extract.

As for GA3, in the two seasons, the three concentrations of GA3 significantly increased fruit length (cm), fruit diameter (cm) and fruit firmness (Ib/ inch^2) compared to the control treatment. In the meantime, there were significant differences among the three GA3 concentrations for fruit length, diameter and firmness which increased by increasing the concentrations of GA3 during the two seasons.

As for NAA, in the two seasons, the two higher concentrations of NAA significantly increased fruit length (cm) and fruit firmness (Ib/ inch2) compared to the control and the lowest concentration of NAA. In the meantime, there were significant differences between the highest concentration (3 mg/l) compared to the middle one (2mg/l), during both seasons. While, the highest concentration of NAA (3 mg/l) caused a significant increase in fruit diameter compared to the control and the two lower concentrations (1 and 2 mg/l) in the first season and compared to the control and the lowest concentration (1 mg/l) in the second season.

Form the above results, seaweed has a good influence on yield and fruit quality and this could be because of its high content of growth promoting hormones like IAA, IBA, cytokinins, gibberellins, and amino acids, vitamins, antibiotics and micronutrients **(Zodape *et al*., 2008).** It is well known that, NAA and GA3 had many functions in plant nutrition and growth that influence physical properties of fruits. These included enhancing metabolic processes such as protein synthesis; cell division and fruit growth. The aforementioned roles of the two growth regulators could explain its effect on improving fruit physical properties and photosynthesis; activation of carbohydrate metabolized for synthesis of amino acids (**Arunadevi *et al*., 2019 and Abd El-Sabor, 2020**) on lime trees.

Table (4): Effect of seaweed extract, GA3 and NAA growth regulators on some fruit physical properties

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit firmness (Ib/ inch^2)	
	Seasons					
	2018	2019	2018	2019	2018	2019
Control	6.30e	7.06e	5.91c	6.62c	4.95g	5.76g
Seaweed 5 mg/l	7.67c	8.59c	5.78cd	6.48cd	5.76e	5.85e
Seaweed 10 mg/l	8.52b	9.54b	6.42b	7.19b	6.40c	7.17c
Seaweed 15 mg/l	9.47a	10.60a	7.14a	7.99a	7.11a	7.96a
GA_3 1 mg/l	7.16d	8.02d	5.46de	6.11de	5.47f	6.13f
GA_3 2 mg/l	7.95c	8.90c	6.34b	7.10b	6.08d	6.80d
GA_3 3 mg/l	8.83b	9.89b	7.04a	7.89a	6.75b	7.56b
NAA 1 mg/l	6.37e	7.14e	5.18e	5.81e	5.16g	5.78g
NAA 2 mg/l	7.8d	7.93d	5.76cd	6.45cd	5.74e	6.43e
NAA 3 mg/l	7.87c	8.81c	6.40b	7.17d	6.37c	7.14c

Means with the same letters within each column are not significantly different at 0.05 level of significance

4.Effect of seaweed extract, GA3 and NAA growth regulators on some fruit chemical characters

Results regarding the percentage of total soluble solids (TSS%), acidity (%), vitamin C (mg/ 100 ml) and total sugars (%) of guava cv. "Maamoura" as influenced by seaweed extract, GA_3 and NAA levels are presented in Table (5).

As for seaweed, in the two seasons, the three concentrations of seaweed extract significantly increased the fruit total soluble solids (TSS), vitamin C (mg/ 100 ml juice) and total sugars (%) compared to the control treatment. In the meantime, there were significant differences among the three seaweed extract concentrations for fruit total soluble solids percentage, vitamin C (mg/ 100 ml juice) and total sugars (%) which increased by increasing the concentrations of the seaweed extract. In contrast, the three concentrations of seaweed extract significantly decreased fruit acidity percentage compared to the control treatment in the two seasons. In the meantime, there were significant differences among the three seaweed extract concentrations for fruit acidity which decreased by increasing the concentrations of the seaweed extract.

As for GA3, in the two seasons, the three concentrations of GA3 significantly increased fruit total soluble solids (TSS) percentage, vitamin C (mg/ 100 ml juice) and total sugars (%) compared to the control treatment. In the meantime, there were significant differences among the three GA3 concentrations for fruit total soluble solids percentage, vitamin C (mg/ 100 ml juice) and total sugars (%) which increased by increasing the concentrations of GA3 during both seasons. In contrast, the three concentrations of GA3 significantly decreased the fruit acidity percentage compared to the control treatment in the two seasons. In the meantime, there were significant differences among the three GA3 concentrations for fruit acidity which decreased by increasing the concentrations of GA3.

As for NAA, in the two seasons, the three concentrations of NAA significantly increased fruit total soluble solids (TSS) percentage, vitamin C (mg/ 100 ml juice) and total sugars (%) compared to the control treatment. In the meantime, there were significant differences among the three NAA concentrations for fruit total soluble solids percentage, vitamin C (mg/ 100 ml juice) and total sugars (%) which increased by increasing the concentrations of NAA during both seasons. In contrast, the three concentrations of NAA significantly decreased the fruit acidity percentage compared to the control treatment in the two seasons. In the meantime, there were significant differences among the three NAA concentrations for fruit acidity which decreased by increasing the concentrations of the NAA.

This considerable rise in TSS content of fruit could be explained by GA3 stimulating the operation of a number of enzymes in the physiological process, which likely caused the reported increase in TSS content of fruit by Garmendia *et al*. (2019). According to, the drop in acidity in growth regulators treated fruits could be related to the quick consumption of organic acid during respiration at maturity by Agnihotri *et al* (2013) and Rajput *et al* (2016).

The GA3 treatment raised the sugar content in the fruit by stimulating the production of the hydrolytic enzyme, which dissolved complex polysaccharides into simple sugar. Growth regulators promoted the transfer of photosynthetic metabolites from other areas of the plant to growing fruits. This discovery is consistent with the findings of Kumar and Rattanpal (2010) in guava. The proportion of total sugars could be ascribed to growth regulators' assist in photosynthesis, which resulted in further oligosaccharides and polysaccharides getting formed. They also control enzymatic activity, ensuring that enzymes swiftly convert starch to soluble sugars, resulting in early ripening in response to growth stimuli. Observations similar to these were made by Agnihotri *et al* (2013) in guava.

Table (5): Effect of seaweed extract, GA3 and NAA growth regulators on some fruit chemical characters

Treatments	TSS (%)		Acidity (%)		VC (mg/100g)		Total sugars (%)	
	Seasons							
	2018	2019	2018	2019	2018	2019	2018	2019
Control	8.37h	9.38h	0.54a	0.61a	167.39h	187.47h	5.64h	6.32h
Seaweed 5 mg/l	10.10e	11.31e	0.40d	0.45d	193.05e	216.22e	7.81c	8.74c
Seaweed 10 mg/l	11.22c	12.56c	0.36e	0.40e	214.50c	240.24c	8.67b	9.72b
Seaweed 15 mg/l	12.46a	13.96a	0.32f	0.36f	238.33a	266.93a	9.64a	10.79a
GA_3 1 mg/l	9.41f	10.54f	0.44c	0.49	177.90f	199.25f	7.02e	7.87e
GA_3 2 mg/l	10.46d	11.71d	0.40d	0.45d	197.67d	221.39d	7.81c	8.74c
GA_3 3 mg/l	11.68b	13.08b	0.35e	0.39e	219.64b	245.99b	8.76b	9.80b
NAA 1 mg/l	9.07g	10.15g	0.49b	0.55b	172.12g	192.78g	6.06g	6.79g
NAA 2 mg/l	9.30f	10.42f	0.44c	0.50c	191.25e	214.20e	6.73f	7.54f
NAA 3 mg/l	10.33d	11.57d	0.40d	0.45d	212.50c	238.00c	7.48d	8.38d

Means with the same letters within each column are not significantly different at 0.05 level of significance

5. Effect of seaweed extract, GA3 and NAA growth regulators on some leaf macro nutrients

The results regarding the percentages of nitrogen, phosphorus and potassium contents of guava cv. "Maamoura" as influenced by seaweed extract, GA_3 and NAA levels are presented in **Table (6)**.

The data in **Table (6)** showed that, in the two seasons, the three concentrations of seaweed extract (5, 10 and 15 mg/l) significantly increased the leaf nitrogen, phosphorus and potassium percentages compared to the control treatment. In the meantime, there were significant differences among the three seaweed extract conentrations for nitrogen, phosphorus and potassium percentages content which increased by increasing the concentration of the seaweed extract.

As for GA3 in the two seasons, the three concentrations of GA3 (1, 2 and 3 mg/l) significantly increased the leaf nitrogen, phosphorus and potassium percentages compared to the control. In the meantime, there were significant differences among the three GA3 concentrations for nitrogen, phosphorus and potassium percentages content which increased by increasing the concentration of the GA3.

As for NAA, in the two seasons, the three concentrations of NAA (1, 2 and 3 mg/l) significantly increased the nitrogen, phosphorus and potassium percentages compared to the control treatment. In the meantime, there were significant differences among the three NAA concentrations for leaf nitrogen, phosphorus and potassium percentages which increased by increasing the concentrations of the NAA.

It was clear that, seaweed contains a high amount of potassium, nitrogen and phosphorous **(Elumalai and Rengasamy, 2012).** The content of macronutrients in the leaves of seaweed extract has been found to improve **(Mancuso *et al.*, 2006)**. In addition, the quantities of K, Fe, and Cu in the leaves of olive trees sprayed with marine extract increased **(Chouliaras *et al.*, 2009**). A promoting of biomass has been shown to exert production of Gibberellic acid induces DNA, RNA, and protein synthesis along with ribose and polyribosome proliferation in vegetative organs. GA3 treated trees accumulate biomass Improvements in enzyme activity and membrane permeability may make mineral nutrient absorption and utilisation easier and transport of photosynthates (**Miceli *et al*., 2019**).

Table (6): Effect of seaweed extract, GA3 and NAA growth regulators on some leaf macro nutrients

Treatments	N (%)		P (%)		K (%)	
	Seasons					
	2018	2019	2018	2019	2018	2019
Control	1.40j	1.57j	0.200h	0.224h	1.85h	2.07h
Seaweed 5 mg/l	1.92e	2.15e	0.347cd	0.388cd	2.65c	2.97c
Seaweed 10 mg/l	2.14c	2.39c	0.390b	0.437b	3.07b	3.44b
Seaweed 15 mg/l	2.37a	2.66a	0.430a	0.481a	3.28a	3.67a
GA_3 1 mg/l	1.81g	2.03g	0.293b	0.329e	2.24fg	2.51fg
GA_3 2 mg/l	2.01d	2.25d	0.327d	0.366d	2.49de	2.79de
GA_3 3 mg/l	2.23b	2.50b	0.363c	0.407c	2.77c	3.10c
NAA 1 mg/l	1.52i	1.70i	0.227g	0.254g	2.13g	2.39g
NAA 2 mg/l	1.69h	1.89h	0.253f	0.284f	2.37ef	2.65ef
NAA 3 mg/l	1.87f	2.10f	0.283e	0.317e	2.63cd	2.94cd

Means with the same letters within each column are not significantly different at 0.05 level of significance

CONCLUSION

The foliar application of seaweed, GA_3 and NAA had a positive effect in improving the vegetative growth, fruit set, yield, fruit quality and leaf mineral content, of 'Maamoura' winter guava trees. Seaweed 15 mg/, GA_3 3 mg/l and NAA 3 mg/l was the best treatments. These treatments had the highest positive effect in improving the vegetative growth, percentages of yield, fruit set, fruit weight, number of fruits per tree, fruit length and width. It also, increased P content in the leaves in the two seasons, as compared to the control treatment. Moreover, it improved significantly fruit firmness. It decreased the percentages of acidity in the two seasons as compared to the control and the other treatments.

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الملخص العربي

الرش بمستخلص الطحالب البحرية وبعض منظمات النمو لتقليل نسبة التساقط وتحسين انتاجية وجودة ثمار الجوافة الشتوي

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اجري هذا البحث خلال موسمي 2018 و 2019 لدراسة تأثير الرش بمستخلص طحالب البحر وببعض منظمات النمو (حمض الجبريللك وحمض النفثالين) علي زيادة عقد الثمار, وتحسين محصول وجودة ثمار اشجار الجوافة الشتوي صنف "معمورة" النامية في منطقة رشيد محافظة البحيرة مصر والمنزرعة علي مسافة 4في 4 متر. الري كان بالغمرونهر النيل هو مصدر المياه. تم اختيار اشجار متماثلة قدر الامكان في الشكل والحجم ويجري عليها نفس المعاملات البستانية التي تجري علي الاشجار الغير معاملة (الكونترول). اشتملت التجربة علي عشر معاملات رش ورقي كالتالي: كونترول (رش بالماء), مستخلص أعشاب البحر (5، 10، 15 ملجم/لتر)، حمض الجبريللين (1، 2، 3 ملجم/لتر) وحمض النفثالين (1, 2, 3 ملجم/لتر). وقد اظهرت النتائج أن حمض الجبريللين بتركيز 3ملجم/لتر ومستخلص اعشاب البحر بتركيز 15 ملجم/لتر اعطوا أعلي نتائج ايجابية لتحسين النمو الخضري , محتوي الكلوروفيل, النسبة المئوية لعقد الثمار, المحصول بالكجم والمواد الصلبة الذائبة الكليه (كنسبه مئويه). أيضا زاد محتوي الاوراق من النتروجين والفوسفور والبوتاسيوم كنسبه مئويه في كلا موسمي الدراسة نتيجة المعاملات بالمقارنة بالكونترول. أيضا حدث تحسن معنوي في عدد الثمار لكل شجرة, وزن الثمرة (جم) وطول (سم) وصلابة الثمار(رطل لكل بوصه2). بينما ادت المعاملات الي خفض في النسبة المئوية للحموضة في كلا موسمي الدراسة بالمقارنة بالكونترول

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